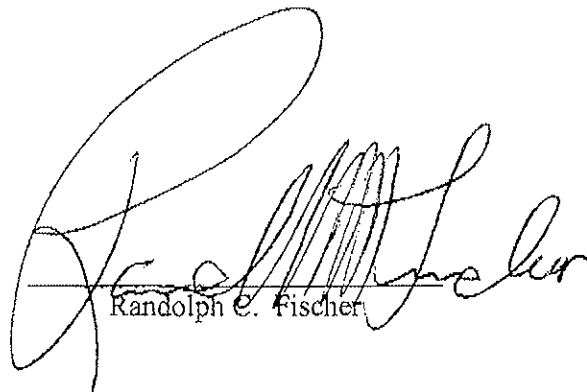


Revised Expert Report of Randolph C. Fischer

January 2008



Handwritten signature of Randolph C. Fischer, written in black ink. The signature is stylized and cursive, with a large loop at the beginning and a series of vertical strokes in the middle. Below the signature, the name "Randolph C. Fischer" is printed in a small, black, sans-serif font.

Randolph C. Fischer

Introduction

This report summarizes the opinions of Randolph C. Fischer, P.E. Mr. Fischer is providing his expert opinions at the request of Mr. Luke Cole, Director of the Center on Race, Poverty & the Environment, 47 Kearny Street, Suite 804, San Francisco, CA 94108.

Mr. Fischer reserves the right to modify and supplement his opinions as further information becomes available, including through deposition and trial testimony of defendant's experts, and to express new opinions in response to new information or to opinions expressed by defendant's experts. Additionally, Mr. Fischer has not been given access to several of the reports and publications on which Teck Cominco's experts relied in making their expert opinions; Mr. Fischer has been informed by plaintiffs' counsel that these documents were requested of Teck Cominco but have not been provided to the plaintiffs. Mr. Fischer reserves the right to modify and supplement his opinions once he has been provided all data and publications on which defendant's experts relied. The fact that Mr. Fischer has focused only on certain statements in Teck Cominco's experts' reports does not reflect his acceptance or agreement with those statements not specifically addressed herein.

Materials Reviewed

In addition to relying on his experience as a professional environmental engineer, Mr. Fischer bases his opinions in this matter, in part, on reviewing the following reports and publications:

1. Andrews, G., T. Mudder, M. Botz, and D. Howe. 1996. *Effluent Treatment and Water Management for TDS Control – Red Dog Mine*. December 1996 for Cominco Alaska, Inc.
2. Andrews, G., T. Mudder, M. Botz, and D. Howe. 1997. *Effluent Treatment and Water Management for TDS Control – Red Dog Mine*. September 1997 for Cominco Alaska, Inc.
3. Andrews, G., T. Mudder, M. Botz, and D. Howe. 1999. *Effluent Treatment and Water Management for TDS Control – Red Dog Mine – 1999 Update*. March 1999 for Cominco Alaska, Inc.
4. Andrews, G. 2004. *Expert Report of Gene Andrews*. Case No. A04-00049 CV. November 15, 2004.
5. Kempton, H., M. Martin, and T. Martin. 2003. *Comparative Cost Analysis of Technologies for Treating Sulfate- and Metal-Contaminated Groundwater*. Acid Rock Drainage Sixth International Conference, 12-18 July, Cairns, North Queensland, Australia.

6. FWR. 2000. *An Economic and Technical Evaluation of Regional Treatment Options for Point Source Gold Mine Effluents Entering the Vaal Barrage Catchment – Final Report*. Report No. 800/1/00.
7. Teck Cominco Alaska. 2002, 2006, 2007. *Discharge Monitoring Reports for Red Dog Mine*.
8. Discovery Responses from Teck Cominco Alaska concerning TDS treatment.
9. Lorax Environmental, *Treatment of Sulphate in Mine Effluents* (2003).

Opinions and Observations

This section presents Mr. Fischer's general observations and opinions regarding effluent treatment at the Red Dog mine and Teck Cominco's efforts to resolve the problem of total dissolved solids (TDS) in its effluent, beginning in the mid-1990s.

At least as early as 1996, the treated effluent discharged from the Red Dog mine caused exceedances of the in-stream limits for TDS in the receiving stream, Red Dog Creek. As early as 1996, Cominco Alaska, Inc. (Cominco), the mine's operator, was aware of the TDS exceedances of the in-stream standards and was petitioning the Alaska Department of Environmental Conservation (ADEC) to reclassify the streams receiving mining effluent. In addition Cominco was petitioning ADEC to develop site-specific stream standards or criteria for mine effluents in receiving streams. In the interim, however, ADEC or the State of Alaska requested that Cominco provide an update and review of potentially applicable technologies for treating or managing the waters being discharged from the site. In 1996, 1997, and 1999, Mr. Andrews prepared and submitted a series of reports on behalf of Cominco to meet ADEC's request for a feasibility analysis of applicable technologies. Mr. Andrews' 2004 expert testimony relies primarily on the 1997 report to conclude that reducing the levels of TDS discharged from the mine to levels capable of meeting the stream standards was infeasible.

Overall Opinions

Based on his experience in mine water treatment and management and in preparing engineering feasibility studies, Mr. Fischer believes the screening of TDS removal technologies and options performed by Mr. Andrews between 1996 and 1999 on behalf of Cominco was incomplete and inadequate in judging the true feasibility of TDS reduction alternatives at the mine. Instead, the work performed by Cominco appears designed merely to delay possible enforcement of the existing stream standards until site-specific standards might be adopted rather than to actually remedy the TDS exceedances caused by the company's discharges. This opinion is based on the following:

- Cominco's efforts to address the TDS exceedances in Red Dog Creek appear limited to performing screening-level evaluations on a small number of potentially applicable technologies. These rather cursory evaluations are presented as evidence of the infeasibility of TDS reductions in the mine's effluent;

- Over a 4-year period from 1996 through 1999, no less than 3 versions of the same technology screening report were prepared to evaluate TDS reduction strategies at Red Dog Mine. These technology evaluations were, at best, suitable as the initial steps in a more thorough and defensible feasibility study. However, over the 4-year period in which these reports were prepared, the level of detailed analysis remains cursory, with no evidence of any bench testing, conceptual designs, or more detailed cost estimates being performed. **No further analysis of TDS options has been provided to the plaintiffs by Teck Cominco.**

- In contrast to the technology screening reports submitted by Cominco, an adequate and complete engineering feasibility study should have included elements, such as the following:

- development and screening of a set of comprehensive alternatives for reducing TDS based on the initial technology screening steps;
- detailed analysis of a set of potentially viable candidate alternatives;
- possible bench-or pilot-scale treatability studies;
- conceptual-level engineering designs and calculations;
- cost analyses with a higher level of certainty than are used in the initial screening step.

- The documents supporting Mr. Andrews' conclusions tend to evaluate the technical capabilities of TDS reduction strategies in isolation from other potentially applicable technologies, i.e. no comprehensive approaches to TDS reduction were presented or evaluated. However, feasible solutions for reducing TDS concentrations in the mine's effluent would most likely exist in the form of comprehensive alternatives consisting of combinations of technologies, such as runoff collection/control and segregation of the most polluted water sources coupled with some form of treatment and on-site disposal of treatment residuals.

- In the absence of a complete and adequate engineering feasibility study, it is not possible to conclude that significant reductions in TDS were infeasible, as Mr. Andrews so concludes based on the technology screening reports submitted on behalf of Cominco in 1996, 1997, and 1999.

- Additionally, the TDS technology screening reports submitted on behalf of

Comino are characterized by presumptions of infeasibility. That is, the technical infeasibility of TDS reduction appears to be presupposed throughout, as evidenced by the following:

- repeatedly questioning the justification for the applicable regulatory standards;
- the lack of detailed engineering and chemical information;
- evaluations based on exaggerated, qualitative, and speculative assertions rather than objective analysis;
- a lack of detailed cost analysis and cost data back-up;
- repeated speculation that there would be no environmental benefit from reducing TDS concentrations, yet providing no chemical or water quality data adequate for documenting the toxicity of the particular TDS being discharged;
- exaggerated cost and time-frame estimates for implementing technological remedies;
- a general absence of supporting documentation, such as water quality data, accurate flow volumes, or removal efficiencies.

Specific Observations

The following specific observations of Mr. Andrews' 2004 expert report are provided in support of Mr. Fischer's opinions stated in this report:

Water Balance, Water Quality, and Treatment Volumes

Frequently, the most cost-effective water quality improvements at mine sites involve the concept of keeping clean water, such as precipitation and run-on, clean through appropriate water management strategies while treating only the smallest possible volumes of dirty water, such as ore processing waters and mine drainage. Treatment options may become more feasible if the volume of water requiring treatment can be significantly reduced. However, opportunities for cost-effective water management and flow reduction measures were not seriously considered and could not be adequately evaluated given the confusing, inadequate or missing data presented in Andrews' reports (Andrews 1996, 1997, and 1999), as follows:

- Andrews (2004) characterizes TDS control as infeasible based, in large part, on the huge volumes (10,000 gpm) of effluent requiring treatment. Instead, supporting

documents frequently suggest that a wide range of treatment options might be feasible if the flow rates were smaller. Yet, opportunities to reduce the volume of mine water requiring treatment are given only cursory consideration in the technology screening reports with no supporting water quality or flow data to back up the qualitative evaluations (Andrews, 1997, p. 31).

- The technology screening reports fail to provide a clear understanding of the site's hydrology and water balance for the purposes of evaluating runoff collection and control, split treatment, or separate treatment alternatives. For example, Andrews (1997) indicates in Table 6 (p.32) that site runoff comprises 80 percent (8,000 gpm) of the inflows to the treatment plant, whereas Figure 4 (p. 10) of the same report indicates site runoff accounts for only about half of the inflows. If, indeed, 50 to 80 percent of the treated effluent was comprised of runoff, why were no runoff control measures evaluated other than those currently in place at the mine site?

- Andrews (1996, 1997, and 1999) consistently states that the technology screenings he performed were based on an assumed flow rate of 10,000 gallons per minute (gpm). To support this assumption, Andrews (1996, p. 19 and 1997, p. 21) indicates "the total treatment system throughput was 15,000 gpm, with 10,000 gpm being intermittently discharged from the site and 5,000 gpm returned to the mill in an internal recycle loop." However, Andrews (1999, p.18) later states that the total treatment system throughput in 1998 ranged from 3,200 gpm to 7,900 gpm with an annual average flow rate of 4,820 gpm. This is approximately half the discharge estimated for 1996 and 1997. There is no explanation of how this significant reduction in flow rates was achieved nor any reexamination of the design assumptions for the technology screening. Still, the flow data presented in 1999 appear to indicate there were opportunities to reduce the flow rates from the stated design assumption (10,000 gpm), thereby altering the presumption of infeasibility for some of the evaluated treatment options.

- Cominco's discharge monitoring report (DMR) for 2002 indicates the volume of water being discharged from the treatment plant was reduced by roughly half the amount being discharged in 1997. This reduction in flow is further evidence that cost-effective water management or flow reduction strategies should have been considered in the evaluation of treatment technologies in Andrews' technology screening reports, as well as his expert report (Andrews 2004).

- An adequate TDS mass balance for the site is not presented in the company's reports, thereby obscuring possible opportunities for managing or treating various water sources differently. For example, **based on no water quality data**, Table 6 (Andrews, 1997, p. 32) indicates up to 67 percent of the TDS load for the site is attributable to site runoff. Yet, no TDS load is attributed to the ore processing or water treatment chemicals that are likely the largest TDS components. Feasible solutions for reducing site-wide TDS loads may have been overlooked because of the poor understanding the TDS mass balance represented by Table 6.

- A complete ion balance, as well as an accurate mass balance are the primary prerequisites for identifying and screening potentially applicable TDS treatment technologies. However, no ion balance is ever presented in any of the technology screening documents. Table 2 (Andrews 1997, p. 15) presents a broad analysis of the site-specific TDS indicating the water is primarily a calcium/magnesium sulfate type effluent. The absence of more detailed water quality information, such as an ion balance renders a true assessment of TDS treatment technologies difficult. For example, gypsum (calcium sulfate) solubility limits obtained through geochemical modeling would be an important parameter for evaluating the potential effectiveness of chemical treatment methods. Andrews (1997, p. 33) indicates the mine effluent is near the saturation point with respect to gypsum. However, there is no follow up discussion on the feasibility of reducing sulfate concentrations through gypsum precipitation technologies.

- Andrews (1997, pp. 15-16) characterizes the TDS at the Red Dog mine as non-toxic except at very high concentrations. This characterization, as well as a lengthy discussion of the regulatory framework (Andrews 1997, p. 5-8) lead to Andrews' (2004, p.7) statement that the environmental benefits of TDS treatment at the Red Dog Mine are not quantifiable. Such characterizations weigh heavily in Andrews feasibility evaluations. Yet, conclusions regarding the non-toxic nature of the TDS at Red Dog Mine are not backed up with any water quality data, whole effluent toxicity (WET) testing results, or ecological risk assessments. The TDS in mining effluent frequently contains potentially toxic metals, metalloids and anions in their dissolved forms. Hence, mine-site TDS cannot be merely assumed non-toxic in the absence of a complete ion balance or WET test results. There are references to ongoing bioassays in the receiving streams (Andrews 1997, p. 8). But no data are presented to support the assumption of non-toxicity. Indeed, this assumption is contradicted by other Teck Cominco disclosures, specifically the DMRs in 2006 and 2007.

Technology-Specific Evaluations

Often, Andrews' speculates about the treatment efficiencies or performance of specific technologies under site-specific conditions concluding these technologies are infeasible to implement. Seldom are any back-up data provided to support these speculative comments. Specific technologies are only evaluated in isolation, never considered in combinations or for use in split-flow treatment systems, i.e. for treating only part of the flow or treating different flows using different technologies to optimize TDS reductions.

- Andrews (2004, p. 5) states that, "Interim treatment options were all unproven for the TDS levels and flows involved with the Red Dog effluent." This statement is false. Several of the treatment technologies evaluated in Andrews' technology screening reports were well proven in 1997 for removing TDS from waters many times more brackish than the Red Dog effluent. In addition, some commonly used treatment technologies are available for achieving the relatively low to moderate removal efficiencies needed for compliance.

- Andrews (1997, p.23) states as an assumption for his technology evaluations that the mine discharge would need to achieve a TDS concentration between 200 mg/L to 1000 mg/L from an average concentration of 2500 mg/L to meet the in-stream standards. This would require removal efficiencies ranging from 60 percent to 92 percent. Later, in 1999, Andrews (1999, p. 20) states that TDS concentrations would need to be reduced from between 2600 mg/L to 3120 mg/L down to 1000 mg/L and 1900 mg/L to meet the in-stream limits. This only would require removal efficiencies ranging from 27 percent to 67 percent.

- The technical feasibility problems cited for membrane technologies are overstated. Andrews assumes all 10,000 gpm would be treated, whereas it might be most cost-effective to treat only a portion of the flow. For example, because divalent anions, such as nitrate and sulfate are probably the most recalcitrant TDS constituents, it might be highly feasible to segregate the major nitrate and sulfate loading sources (i.e. mine drainage) and treat those sources by nano-filtration to remove nitrate and sulfate before combining with other wastewater sources. Once the sulfate loads are reduced, it could be possible to remove other TDS constituents using conventional chemical treatment, possibly in the existing treatment plants. Unfortunately, data presented in the technology screening documents are insufficient to evaluate such possible alternatives, nor were any such split-flow alternatives developed or evaluated by Andrews.

- Andrews assumes that deep-well injection would be the only possible alternative for disposing of the concentrated reject stream from an RO or nano-filtration system. However, chemical treatment would also be possible and would likely be readily feasible.

Exaggerated Cost Estimates

In Mr. Fischer's opinion, the cost estimates presented in the technology screening documents (Andrews 1996, 1997, and 1999) are exaggerated, as follows:

- The stated level of accuracy for the cost estimates (+/- 40 to 50 percent) is too broad for meaningful evaluation of the options. In addition, it is unclear if the cost figures presented in Table 8 (Andrews 1997, p. 39) represent the median costs or the upper or lower bound costs of the stated range of accuracy. Assuming the costs presented in Table 8 represent the median of the range of accuracy, then the capital construction costs for RO, for example, could range between \$41.25 million to \$68.75 million.

- Although the area multiplier of 2.5 seems excessive, it is granted that any construction in such a remote location would be considerably more expensive than in the mainland US.

- The level of contingency allowances for the capital costs is quite large, ranging from 18 percent for the ocean pipeline option to 40 percent for deep-well injection and

reverse osmosis. These large contingency factors appear to be in addition to the already wide range of accuracy. These large contingency factors have the effect of inflating the cost estimates and enhancing the impression that the technologies are prohibitively expensive.

- No cost sensitivity analysis is presented in Andrews' reports (1996, 1997, and 1999). For example, the cost detail presented for RO treatment failed to examine the affects of scaling down the size of the system from 10,000 gpm. Also, only the most expensive method for brine disposal was included in the costs, i.e. evaporative disposal, while other disposal or treatment methods might be less costly. Hence, it appears only the upper bound costs estimates are presented in Table 8 and Appendix A (Andrews 1997), whereas sensitivity analysis might reveal alternatives that cost significantly less.

- Instead of normalizing the costs to present-day dollars by performing a present worth analysis, the capital and operating and maintenance (O&M) costs presented in Table 8 (Andrews 1997) are simply summed over the assumed 15 year life cycle, plus interest on the capital costs. This makes the cost appear much higher than necessary, whereas present worth analysis would give a more realistic representation of the costs in terms of present-day dollars. For example, Andrews (1997, Table 8, p. 39) indicates the 15 year owning cost of the RO treatment system would be \$153.5 million. In contrast, present worth analysis for the same RO system reveals that the present worth of the RO option (total capital and O&M costs over 15 years) would range between \$81.8 million and \$88.8 million assuming a discount rate of 5 percent and 3 percent, respectively.

- Present worth can be interpreted as the total investment required today to build and operate a plant over its estimated life cycle. Present worth costs are often preferred for comparative analysis of alternatives because they normalize the costs of all alternatives to present day dollars.

- The interest rate or discount rate applied by Andrews (1997, Table 8, p. 39) to his cost analysis is 2 to 3 times higher than interest rates in recent history. The use of a 10 percent interest rate has the effect of greatly inflating the cost estimates. Inflation over the past decade has only ranged between 1 to 2 percent per year.

Possible Alternatives Not Considered

Andrews (2004, and 1996 – 1999) failed to consider many currently available, proven or experimental technologies for reducing TDS concentrations in mining effluent. Some these technologies were available in the mid-1990s when Andrews work on behalf of Cominco was performed, although the timeframe of availability for others is unknown to Mr. Fischer. Possible treatment options not considered include the following:

- Gypsum precipitation using lime (reduces sulfate to <1,000 mg/L), known and available for decades;

- Barium Salts – precipitates sulfate in the form of barium sulfate, known and available for decades;
- SAVMIN – gypsum precipitation using lime and bauxite refining residuals called ettringite (reduces sulfate to < 200 mg/L), documented uses by late 1990s;
- Cost-Effective Sulfate Removal (CESR) – Similar to the SAVMIN process;
- GYP-CIX –sulfate removal using fluidized bed ion-exchange resins and generating a gypsum sludge that could be disposed of on site (reduces sulfate to < 200 mg/L), reported in *Environment and Water Management* in 1992;
- SPARRO – modified RO system, precipitates gypsum on seed crystals instead of on membrane surfaces, thereby reducing membrane fouling (reduces sulfate to < 200 mg/L);
- Nano-filtration with lime treatment of the brine stream, patented by HW Process Technologies (reduces sulfate to < 200 mg/L);
- Hydrothermal Sulfate Reduction (HSR) – Developed by the Wren Group Pty. Relies on the sensitivity of gypsum solubility limits to temperature to precipitate sulfate in the form of gypsum;
- Biosulfate – biologically reduces sulfate to sulfide and precipitates a wide range of metals for possible economic recovery, pilot plant operating at Britannia Mine, B.C., Canada, prior to 1997;
- Biological sulfate reduction combined with zero-valent iron (ZVI) – ZVI acts as a powerful reducing agent to aid in biological sulfate reduction processes, ZVI research dates back to mid- to late 1990s.

Administrative Feasibility

Andrews judges some technologies to be infeasible based on perceived administrative implementability problems. For example, Andrews (2004, p. 5) states, "the pipeline and injection options would have required extensive study and permitting. Injection of this magnitude may not be allowable under federal guidelines." Also, "implementation would likely have required years." Administrative implementability is only one of many factors to be considered in engineering feasibility studies. The time required to obtain permits is generally not considered a fatal flaw in an alternative's implementability, given a good-faith effort to remedy the TDS compliance issues. For example, while Cominco expended 4 years preparing slightly different versions of the technology screening reports, considerable progress toward solving the perceived administrative obstacles could have been made. Further, it is now more than 10 years after the initial Andrews' studies, and almost 10 years since the EPA imposed an effluent limitation for TDS at

Outfall 001, and Teck Cominco is still violating that effluent limitation.

Regarding his statements on the administrative feasibility of deep-well injection, Andrews assumes that all 10,000 gpm of the mine's effluent would require disposal. However, the administrative implementability challenges as well as the technical challenges to injection might be overcome by designing a comprehensive alternative in which injection is only one component, for example, for disposing of the reject from a nano-filtration system.

The hypothetical time scale presented by Andrews (2004, p. 5 through 7) as an example of the process and schedule required to gain regulatory approval of a new treatment technology is exaggerated. As only one of many possible examples, Andrews states that a total of 25 months would be needed to perform bench-scale testing, report the results, and select an alternative based on the testing results. This time estimate is excessive. Given a good faith effort, bench testing could be accomplished in less than one fourth to one third as much time. Other time requirements stated by Andrews are similarly exaggerated.

It should be noted that, according to the documents, the mine water treatment process was altered between 1997 and 1999 by the addition of a sulfide precipitation unit. Despite the administrative obstacles cited by Andrews for implementing TDS technologies, the treatment process was modified by adding a sulfide precipitation unit within a two-year time period, i.e. between the last two versions of the technology screening reports.

The cost estimates for these services that I provided in writing are reasonable and reliable based on my 17 years of professional engineering experience conducting site investigations and feasibility studies. My experience participating in multi-million dollar site investigations and feasibility studies has provided me with the knowledge needed to reliably estimate the level of effort and specific activities required to conduct such studies at different sites to meet different objectives.

It should be noted for clarity that my written estimates were for an engineering feasibility study and site investigation. TCAI frequently refers to my estimates for "pilot studies." Pilot studies were included in my estimates as only one of many components of a complete site investigation.

Cost estimates for providing engineering services, such as feasibility studies and environmental site investigations, are by nature based on professional judgement and experience. In fact, the application of sound professional judgement and experience to normal standards of practice is the only reliable method available for providing cost estimates for engineering services.

Based on my 20 years of mining-related experience as an environmental engineer and my 20 years of experience in performing engineering cost estimates as well as costs

estimates for providing professional engineering services, such as site investigations, feasibility studies and pilot-scale treatability testing, the Andrews expert reports provided me with sufficient facts and data to prepare a cost estimate for performing a site investigation and feasibility study, including pilot studies for TDS control technology in this case.

In preparing the cost estimate in this case, I used the principles and methods common in my profession, and which I have used in numerous previous cost estimations over the past 20 years. These are the same principles and methods I used when estimating the costs as an expert witness in *Asarco, Inc. v. Andalex Resources, Inc.* in 1997, a case involving an abandoned lead and zinc mine. These are also the same principles and methods I used to estimate the costs of conducting a feasibility study and pilot-scale treatability tests at the Summitville Mine site located at an elevation of 11,500 feet in the Colorado Rocky Mountains, an alpine tundra location not unlike the Red Dog Mine's location.

Nearly every project I have worked on during my 20-year career as a professional engineer has required me to provide my clients with an estimate of the costs for labor, expenses and other resources needed to complete the project. I applied my experience in providing these estimates for professional services, as well as the principles and methods common to my profession, to the data provided in the Andrews expert reports to prepare the cost estimates in this case.

Qualifications

Mr. Fischer's qualifications as an environmental engineer are summarized in this section. Detailed information about his qualifications are presented in the attached *Curriculum Vitae*.

Education

M.S., 1989, Civil/Environmental Engineering, Colorado State University;
B.S., 1976, Natural Resources Management and Biological Sciences, Colorado State University

Professional Registration

Professional Engineer, Colorado Reg. No. 31660;
Wyoming Reg. No. 8553

Experience

Randolph C. Fischer is a private consulting environmental engineer providing design and process engineering expertise for remediation of sites contaminated with acid mine drainage, organic compounds, cyanide, and heavy metals. Mr. Fischer performs

technology evaluations, treatability testing, and design of passive and active systems for treatment of acid mine drainage, mine waters, and mining wastes. He is a process designer of industrial and municipal wastewater treatment systems with experience in designing and performing bench- and pilot-scale wastewater treatability studies. Mr. Fischer is also experienced in managing and conducting field pilot testing and designing, installing, and operating soil vapor extraction, air sparging, and two-phase vacuum extraction systems at solvent and hydrocarbon contaminated sites. International project experience includes projects in Canada, Australia, Brazil, Japan, Mexico, Argentina, Venezuela, Ecuador, Peru, and the Sultanate of Oman. He has also testified as an expert witness in several cases, preparing cost estimates and engineering evaluations for remediation of an open-pit lead and zinc mine in Missouri (Jasper County Superfund site), and preparing cost estimates for the remediation of petroleum contamination at the Northglenn Mall site near Denver.

Representative Projects

Projects representing Mr. Fischer's professional experience are summarized, as follows:

- **Inter-American Development Bank (IDB) 2002 to 2003** - Environmental engineering consultant on an acid mine drainage project in southern Brazil as a subconsultant to Environment and Energy Solutions, Inc. of Tokyo, Japan.
- **Japanese International Cooperation Agency (JICA) – 2000 to 2001** - Served as remediation engineer for a multi-disciplinary team of scientists and engineers working with the Omani Ministry of Commerce and Industry to mitigate groundwater pollution from a copper mining and smelting facility in the Sohar Mining District in the Sultanate of Oman.
- **Japanese International Cooperation Agency (JICA) 1997 through 1998** – Worked with the Brazilian government to reclaim areas in the state of Santa Catarina, Brazil, affected by coal mining activity, with emphasis on mitigating the effects of acid rock drainage (ARD).
- **Summitville Mine Superfund Site, 1995 - 1996** - Managed treatability studies and designed bioremediation systems for cyanide-contaminated wastes and leachate solutions at the abandoned mining site in southwestern Colorado.
- **Jasper County, Missouri, Superfund Site, 1994** - Managed field and laboratory treatability studies of passive mine drainage treatment opportunities at the Jasper County portion of the Tri-State lead/zinc mining district.
- **Sydney, New South Wales, Australia, 1996** - Designed a groundwater remediation systems for a former chemical plant site.

- **Wyoming Department of Environmental Quality (WDEQ) 1995 - 1999** - Managed remediation of five leaking underground storage tank (LUST) sites in Laramie, Wyoming.

- **Mining-related CERCLA Feasibility Studies** – Mr. Fischer has completed or is currently working on the following feasibility studies at mining-related superfund sites:

- Bunker Hill, Idaho, Superfund Site (gold/silver mine site) - 1991;
- OU-3/OU-4, Cherokee County, Kansas, Superfund Site (lead/zinc mine site) - 1995;
- OU-6, Cherokee County, Kansas, Superfund Site (lead/zinc mine site) - 2003;
- OU-1/OU-4 of the Jasper County, Missouri, Superfund Site (lead/zinc mine site) – 1994 - 2002;
- OU-1 of the Tar Creek, Oklahoma, Superfund Site (lead/zinc mine site) – current.

- **Mine Environment Neutral Drainage (MEND) Program, 1998 – 1999** - Prepared sections on passive treatment of acid mine drainage for the Acid Rock Drainage Treatment Technology Handbook. This handbook is a comprehensive manual on the chemistry, causes, environmental impacts, and control of acid mine drainage. The treatment handbook is available from Natural Resources Canada.

- **Eagle Mine Superfund Site, Gilman, Colorado, 1990 - 1992 and 1998.** Performed laboratory- and field-scale treatability tests leading to the design of a 500 gpm mine-water treatment plant. Also conducted treatability tests to evaluate the feasibility of implementing passive mine water treatment at the site.

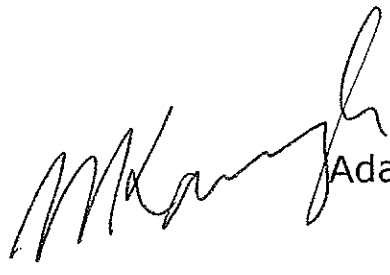
Compensation

Randolph Fischer is a private environmental engineering consultant and is being compensated at the rate of \$85 per hour for preparation of this report.

Other Cases

Mr. Fischer has not worked on other cases as an expert witness in the past 4 years.

Revised Report of Michael Kavanaugh

 Adams et al.
v.

Tech Cominco Alaska Incorporated et al.

January 18, 2008

Expert Report of Dr. Michael Kavanaugh
(Revised January 2008)

1.0 Summary

This is the revised report of Dr. Michael Kavanaugh, an economist with more than thirty years experience applying the principles of economics to environmental and natural resource issues.¹ I have been qualified at least twelve times as an expert witness in Federal Court and I have given many sworn depositions. My experience and my testimony since 1990 are more fully summarized in the attached vitae.

This report is based on information available to me as of January 14, 2008. I may amend this report if more information and data become available, particularly data about the costs of treatment options needed to comply with the Total Dissolved Solid (TDS) permit limits.

This report focuses on the economic benefit gained by Teck Cominco Alaska Incorporated (TCAI) by exceeding its TDS limits at its Red Dog mine.² I focus on TDS limits because they are the bulk of the violations found by the Court in its Summary Judgment order.³ The specific pollution control projects that were needed to bring the Red Dog mine into compliance with its Clean Water Act discharge permits are

¹ My initial report is dated December 24, 2004. Since that time there have been significant rulings by the court including its Order and Opinion, [Docket 136] 3:04-CV-00049JWS. This report attempts to address the Court's rulings. I also authored a rebuttal report dated January 10, 2005. I have not revised that report and append it to this report.

² TCAI is the operator of the Red Dog mine. Its ultimate parent is Teck Cominco Ltd, a mining company that explores, develops and produces metal and minerals worldwide.

³ Order and Opinion, [Docket 136] 3:04-CV-00049JWS @ p.30-31.

unknown. Plaintiffs' engineering experts suggest a process consisting of feasibility and investigative studies followed by implementation of a suite of compliance projects. Similarly, TCAI conducted screening studies that identified several control measures.

TCAI discharges water at its Red Dog mine site and at its port site during mining operations that generate positive cash flows.⁴ At the mine site water is discharged into waters of the United States that is polluted during processing of ore into concentrates and from runoff from slag heaps; at the port site discharges result from operation of a sewerage treatment plant and from drainage from concentrate storage.⁵

The discharged water is required to meet the limits of a discharge permit. Typically, meeting discharge limits requires spending funds to construct and operate pollution control equipment. Funds not spent for pollution control are available to TCAI for other remunerative projects. The value of the funds made available is measured at their equity cost and at a weighted-average of their equity cost and their debt cost (WACC).

The limits of TCAI's discharge permits for Red Dog were modified as of August 28, 2003 and became effective June 15, 2004. The pollution control projects needed to meet the limits after June 15, 2004 are not the same as those that

⁴ TCAI operates the largest zinc mine in the world and is likely to remain doing so for the foreseeable future. See the Letter to shareholders and employees from David Thompson, President and Chief Executive Officer, Cominco Annual Report 1999, Feb 29, 2000. Cash-flow data from TCAI financial statements at TC 027808 RD, TC 027734 RD and TC 027695 RD.

⁵ Revised Complaint for Declaratory and Injunctive relief and Civil Penalties, ¶18, ¶40.

were needed between June 1, 1999 and June 15, 2004, and during Arctic Grayling spawning season (late May to early June each year). As a result, TCAI avoided entirely the spending for projects that were needed for compliance with the unmodified permit, had the use of the funds not spent for pollution control, and gained an economic benefit from noncompliance.

Economic benefit is a statutory penalty factor under the Clean Water Act. It is the cash that if removed from the defendants today will leave them in the same financial position as they would be in had they complied with the Clean Water Act in the past. TCAI - unless it observed the limits of its mine site and port site discharge permits -- was not permitted to discharge to the waters of the United States. TCAI, however, did not comply with the limits in its permits and discharged to waters of the United States.⁶ In so doing it avoided the spending needed for determining, building and using the pollution controls that would make the discharges meet the limits in its permit. For avoided costs economic benefit is measured as the after-tax, present value of the cash flows needed to purchase and operate the controls needed for compliance with the permit.

The economic benefit analysis in this report is based on:

- Cost estimates from studies performed for the Red Dog mine (Section 3.1.1);
- Compliance and noncompliance dates (Section 3.3);
- Rates of price change (Section 3.4);
- The statutory limit of U.S. and Alaska corporate income tax rates (Section 3.5);

⁶ See the Summary Judgment Order, [Docket 136] 3:04-CV-00049JWS.

- The opportunity cost of capital (Section 3.6); and,
- Payment of a penalty by July 1, 2008; later payment increases the benefit.

Sections 2 and 3, respectively, describe and apply the method and data used in the benefit analysis. Briefly, the method is an after-tax, present value analysis. The data are publicly available or available from the defendants.

TCAI, in my opinion, gained an economic benefit of \$27 to \$35.3 million because it failed to comply with the TDS limits in its discharge permit when it discharged water from Red Dog to waters of the United States. The range results from alternative measures of the opportunity costs of the funds needed for pollution control.

I reviewed and used TCAI financial statements from 1998 to 2006 to conduct a financial analysis to determine the defendant's ability to pay a penalty. I describe this analysis in Section 4. I conclude that there is a 70% chance that TCAI can generate sufficient cash flows to pay a lump sum penalty payment of \$27 million.

According to Section 309 (d) of the Clean Water Act, 33 D.S.C. 1319 (d), there are other factors (e.g., seriousness of the violations, deterrence) that a Court may consider when assessing a penalty. This report addresses only economic benefit and financial impact. Accordingly, for deterrence or to address the seriousness of the violation a penalty in excess of economic benefit is needed.

Appendix A contains my resume and a listing of trial and deposition testimony given since January 1990. I am

compensated on all work on a time and material basis at the rate of \$125.00/hr.

2. Economic Benefit Method

The federal environmental laws and their implementing regulations set minimum standards for protecting human health and the environment. When minimum standards are not met, civil penalties may result. One part of a civil penalty is the economic benefit that a violator gained by failing to meet the standard. Other parts of the civil penalty may include the seriousness of the violation, the willfulness of the violation, the harm to the environment and any other factor justice may require.

Removing the benefit helps level the economic playing field and helps prevent violators from obtaining an unfair financial advantage over competitors who complied. Removing the economic benefit is a first step in providing an incentive to protect the environment and public health and to help deter future violations by the violator and others.

Economic benefit is the cash that if removed from the defendant today will leave it in the same financial position had it acted to make its discharges comply with the terms of its permit. Since removing economic benefit only returns the violator to the same financial position it would have been in had it complied on time, additional penalty amounts may be needed to address the other penalty factors such as deterring future illegal behavior.

Economic benefit focuses on the violators' economic gain from noncompliance. The gain may occur because the

violation gained a revenue advantage by acting illegally or because it gained a cost advantage by delaying or avoiding necessary pollution control expenditures. The gain arises because funds not spent on environmental compliance are available for other, remunerative projects. The gain arises regardless whether the defendant acted deliberately to delay or avoid compliance, or even if the defendant had been unaware of its noncompliance.

For avoided costs economic benefit is measured as the after-tax, present value of the cash flows needed to determine, build and operate the controls needed for compliance with the permit. For delayed costs the benefit is measured as the after-tax, present value difference between the cash flows needed to comply on-time and the cash flows used to comply late.^{7,8} Although unlikely, if pollution controls are unavailable then - to conform its discharges to the terms of its permits - a discharger would have to reduce or cease production. In this instance, the benefit is measured as the after-tax, present value of the cash flows from the operations that produced the extra production.

⁷ Delayed pollution control spending may be of two types: recurring and one-time. For one-time costs, I calculate the benefit as follows. First, I compute the after-tax present value (ATPV) of purchasing the item on time. Second, I compute the ATPV of purchasing the item later. Third, I find the difference between the first and the second sums. The difference is the benefit.

⁸ For recurring costs, I would compute the benefit in three steps. First, I would calculate the after-tax cash outlays associated with installing the pollution control system on time and operating it into the future using a replacement cycle for the system equal to its useful life. I would express the outlays as a single figure in today's dollars. Second, I would calculate the after-tax cash outlays associated with installing the same system later and operating it into the future using a replacement cycle for the system equal to its useful life. I would express the outlays as a single figure in today's dollars. The same time horizons are used for both the stream of cash outlays that begin on time and the stream of cash outlays that begin later. Third, I would subtract the second set of outlays from the first set of outlays. This difference is the economic benefit.

"After-tax" means to allow for the deductions available for business spending. "Present value" means placing cash flows on a common temporal basis so that a comparison may be made. An economic principle is that cash-flow value depends on when it occurs. A cash flow today is worth more than a cash flow tomorrow because today's flow can be invested and earn additional revenue. A future flow is adjusted to present value by estimating the return earned on a present cash flow so that the present flow, plus its return, equals the future flow. Opportunity cost quantifies this economic principle. It is a scale that states by how much a present dollar exceeds a future dollar. This depends on the company's earning opportunities from its business resources. I estimate the earning opportunities available from business resources by using the capital asset pricing model.

This approach is consistent with the approach of the U.S. Environmental Protection Agency (EPA) for estimating the economic benefit of non-compliance.⁹ I use this approach in other environmental enforcement cases and Courts have accepted it (e.g., *PIRG v. PD Oil Terminals*; *SCLDF v. CC of Honolulu*, 90-00219 ACK; *Friends of the Earth v. Laidlaw Environmental Services (TOC) Inc.*, DSC 3-92-1697-17).

3.0 Application of Economic Benefit Method

This economic benefit calculation is focused on violations of permit limits for TDS because the Court found 621 violations at the mine site for TDS.¹⁰ I find that TCAI gained an economic benefit because it avoided the capital

⁹ The approach is detailed in the *BEN Users Manual*.

¹⁰ See the Summary Judgment Order and Opinion, [Docket 136] 3:04-CV-00049JWS.

and the operating and maintenance (O&M) cost for TDS control projects from June 1999 to June 2004 and the costs for controlling TDS during the Arctic Grayling spawning season in late May and early June in 2005, 2006 and 2007. The benefit is calculated using an equity cost of capital and, alternatively, a weighted-average cost of capital.

The approach I followed may be summarized as follows. First, I reviewed screening studies produced for TCAI of possible pollution control projects at the Red Dog mine site. I selected a highly-ranked, low-cost pollution control project to serve as an indicative project. Next, I applied an annual rate of price change to estimate O&M from 1999 to 2004 and for a two-week Arctic Grayling spawning season in late May and early June of 2005, 2006 and 2007. Then, I found the after-tax value by depreciating the capital costs and expensing the O&M costs. I used statutory maximum federal and state tax rates to conduct the tax analysis. Finally, I found the present value as of July 1, 2008, using, alternatively, an equity cost of capital and a weighted average cost of capital.

The results are based on:

- cost estimates from defendant's screening studies;
- dates of compliance, non-compliance, and expected settlement or penalty payment;
- rates of price change;
- the statutory limits of U.S. and Alaska corporate income tax rates; and,
- the opportunity cost of capital.

3.1 Control Costs

TCAI commissioned screening studies for its Red Dog mine that discussed various control options for and estimated capital and operating costs.^{11,12} I use a 1999 study performed for TCAI to indicate the magnitude of the lower bound of costs TCAI avoided in failing to implement the projects it needed if it were to comply with its discharge permits for TDS control at Red Dog between June 1999 and June 2004 and during the Arctic Grayling spawning season in 2005, 2006 and 2007.¹³

While I do not know that any particular project would achieve compliance, I am proposing that spending on the order associated with these projects was needed. Table 6 of the 1999 report ranks projects for TDS management based on annual operating and maintenance costs plus amortized capital cost. The two highest ranked projects (i.e., the projects with the lowest costs) have capital costs (in 1999\$) ranging from \$13.8 million to \$15.3 million and annual O&M cost (in 1999\$) ranging from \$750,000 to \$2.5 million. I estimate the economic benefit from avoiding the costs associated with the highest ranked project (i.e., the project with the lowest cost). I believe that using the low-cost project is a cautious approach since a higher cost

¹¹ *Effluent Treatment and Water Management for TDS Control, Teck Cominco Mine*, Andrews et al., December 1996; *Effluent Water Management Options for Additional Control of Key Metals, Teck Cominco Mine*, Andrews et al., August 1997, and *Update, Effluent Treatment and Water Management for TDS Control, Teck Cominco Mine*, Andrews et al., March 1999.

¹² See also *Treatment of Acids in Mine Effluents*. It is a generic study of acid control at mines. It reviews technologies whose costs exceed the range I used in making the estimates used in this report.

¹³ 1999 *Update, Effluent Treatment and Water Management for TDS Control, Red Dog Mine*, Andrews et al., March 1999.

project might have been needed. The costs associated with the project I selected have capital outlays of \$15 million and annual O&M of \$750,000.

3.2 Dates

The dates that underlying the benefit estimate are:

- Capital - June 1, 1999
- O&M - June 1, 1999 to June 15, 2004, and a two-week period in late May and early June of 2005, 2006 and 2007 for the Arctic Grayling spawning season.

3.3 Measures of price change

The costs of the screening options in the defendants' report are stated in 1999\$. To estimate O&M from 1999 to 2007, I apply average annual rate of price change to this data. The rate varied over the period from 2% to 2.7%. I gave more weight to price changes in the early part of the period because that is when most of the violations occurred. I use the average price change in the economy over the period 1999-2004 of 2.0%.¹⁴

3.4 Taxes

I adjust for tax effects using the combined statutory limits of U.S. and Alaska corporate income tax rates of 41.1%.¹⁵ I depreciate capital costs using the minimum length of time permitted by U.S. tax code.

¹⁴ This rate is reported in the Economic Report of the President 2005, statistical section.

¹⁵ The Federation of Tax Administrators web site at www.taxadmin.org reports a statutory maximum rate for Alaska at 9.4% and IRS publication #542 reports the corporate tax rate at 35%. The combined rate is 41.1%. This rate is the "custom" rate for Alaska in EPA's current BEN Model.

3.5 Opportunity cost

I measure opportunity cost in two ways. First, I measure the equity cost of capital by applying the capital asset pricing model to a project of average risk. The model estimates the expected return to equity by adding a risk-free rate to a risk premium. The risk-free rate is the return on U.S. Treasury bills and the premium is the amount by which stock market returns exceed returns on Treasury bills. Ibbotson Associates reports this information in *Stocks, Bonds, Bills and Inflation: yearbook*. The equity cost of capital is 12.1%. Second, I calculate the weighted-average cost of capital. This approach blends the equity cost of capital with borrowing cost. I reviewed TCAI's financial reports for 1998-2006 and found a capital structure of 42% debt, and 58% equity with a borrowing cost of a rate 8.4%. I combined this information with an equity return to produce a WACC estimate of 9.1%. For projects that do not produce a positive cash flow and therefore cannot generate the cash flows to repay principle and interest on debt, I favor using the equity return as the better measure of opportunity cost.

3.6 Results

TCAI -- because it did not observe the limits of its discharge permit-- was not permitted to discharge to the waters of the United States. TCAI, however, discharged to water of the United States and avoided the spending needed to observe the limits in its discharge permit. The benefit from avoiding the installation and operation of the needed equipment ranges from \$27 to \$35.3 million.

	Equity	WACC
Capital	30.1	22.7
O&M	5.2	4.3
Total	35.3	27.0

4.0 Financial Impact

I reviewed the annual financial reports of TCAI from 1998 to 2006 and used the information in its financial statements to perform a cash-flow analysis that is consistent with EPA's ABEL model.¹⁶

A cautious method for identifying the financial effects of a penalty on a violator is to examine the historical ability to generate cash flows from operations. Typically, a company has other sources of revenues but they are not included in the analysis in this section. These other sources include funds from:

- financing activities such as loans;
- asset sales;
- increased contributions of equity;
- insurance policies; and
- accruals.

I use the cash flow from operations for TCAI as reported for the years 1998 to 2006. The cash flows are shown below and are based on TCAI's financial statements.

¹⁶ The Approach is detailed in the *ABEL User's Manual*.

Year	reported (\$, 000)	Constant 2008\$ (\$, 000)
1998	43,864	53,470
1999	69,402	82,942
2000	71,917	84,262
2001	1,555	1,786
2002	77	87
2003	36,078	39,833
2004	167,411	181,211
2005	246,564	261,656
2006	751,561	781,924
mean		165,241
Std deviation		246,321

Adjusted to constant 2008\$ using GDP price index rate of 2.0% per year

I note that cash flows from operations increased spectacularly in recent years (see 2003 to 2006) reflecting, in part, increases in commodity prices. Indeed, TCAI's parent boasts that the Red Dog mine made over \$1 billion in operating profit in 2006.¹⁷ The impact of a penalty on TCAI is diminished materially if the analysis were confined to the more recent years. I took a longer view and a more cautious approach, however, and used 1998 to 2006 data.

I computed the average and standard deviation of operating cash flows for 1998 to 2006. I found an average annual cash-flow of \$165 million with a standard deviation of \$246 million. I used the Student-t distribution to determine the probability that next year's cash flow would exceed \$27 million. I found that there is a 70% probability that TCAI will generate at least \$27 million in cash.

¹⁷ See annual Report of Tech Cominco, 2006 p.19.

Sources Considered

Economic Report of the President, Council of Economic Advisors, U.S. GPO, January 2006.

Stocks, Bonds, Bills and Inflation, Ibbotson Associates,

BEN Users Manual, USEPA, 1993, 1997, 1999

Teck Cominco Alaska Incorporated, Consolidated Financial Statements, 1998-2006

Annual Report of Tech Cominco, LTD. 2001 -2006.

Effluent Treatment and Water Management for TDS Control, Red Dog Mine, Andrews et al., December 1996;

Effluent Water Management Options for Additional Control of Key Metals, Red Dog Mine, Andrews et al., August 1997,

Update, Effluent Treatment and Water Management for TDS Control, Red Dog Mine, Andrews et al., March 1999

Treatment of Sulfates in Mine Effluents, Lorax Environmental, International Network for Acid Prevention, 2003

Revised Complaint for Declaratory and Injunctive Relief and Civil Penalties

ABEL User's Manual, USEPA

IRS publication # 542

Order and Opinion [Docket 136] 3:04-CV-00049JWS

Cominco Annual Report 1996-2000

Formulas used

Avoided spending:

Capital

Cost = quote \times (1 + price change)^(quote date - on-time date)

After tax = cost - present value of depreciation

Present value of depreciation = cost \times depreciation rate \times tax rate \times
present value factor

Benefit = after tax \times (1 + opportunity cost)^(trial date - on-time date)

O&M

Cost in year i = quote \times (1+price change)ⁱ \times (1-tax rate)

Benefit = (costs i to j) \times (1 + opportunity cost)<sup>(July 1, 2008 – year
i,...j)</sup>

Rebuttal Report of Dr. Michael Kavanaugh

In

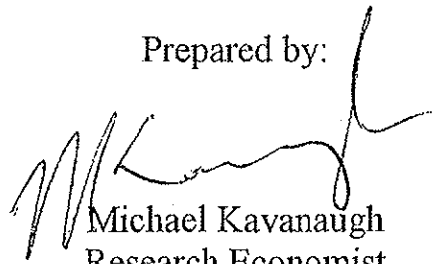
Enoch Adams et al.

v.

Teck Cominco Alaska Incorporated

Prepared For
Luke Cole
Attorney for the Plaintiffs

Prepared by:

A handwritten signature in black ink, appearing to read 'MKavanaugh', is written over the printed name.

Michael Kavanaugh
Research Economist
160 Wood Street
Batavia OH 45103
(513) 732-3939

January 10, 2005

I declare under penalty of perjury that the contents of this report
is true and correct to the best of my knowledge.

Rebuttal Report of Dr. Michael Kavanaugh

1. Summary

In my report of December 24, 2004 I estimated Teck Cominco's economic benefit for avoiding compliance with its total dissolved solids (TDS) limits at its Red Dog mine from June 1, 1999 to August 28, 2003. The benefit for avoiding compliance ranged from \$27.2 to \$30.8 million.¹ The range results from using either the equity method or a weighted-average cost of capital method to value the opportunity cost of the funds that Teck Cominco should have used to comply with its permit that allowed discharges to waters of the United States. In November 2004 one of defendant's witnesses, Mr. Robert Fuhrman, made a benefit estimate of \$100,000 for all of the claims in the Revised Complaint.²

The key analytic differences between the analyses underlying the economic benefit estimates made by the parties and likely to be offered to the Court are:

- Differences in the manner and cost of complying with the discharge permit (the compliance scenario); and
- Differences in valuing the opportunity costs of the avoided or delayed pollution control spending.

I defer to the opinion of plaintiffs' attorneys and plaintiffs' engineering experts on the appropriateness of the compliance scenarios offered by the defendant. Nevertheless, in Section 2, I make some observations on the appropriateness of the defendant's compliance scenario and record some differences between the scenario I used and the defendant's scenario. In general terms, defendant's estimate is based on its failure to get the discharge permit changed before production expanded or to spend sufficient funds to conduct tests, change practices or install and operate equipment. For example, in a most unusual compliance scenario for total dissolved solids (TDS), defendant's expert argues that the benefit arises

¹ "Expert Report of Dr. Michael Kavanaugh", December 24, 2004, Section 3.6.

² Fuhrman, Robert, "Analysis of Economic Benefit in Adams et al. v. Teck Comico Alaska Incorporated," p.18.

because the company failed to get the discharge permit changed in 1998.³ In another compliance scenario defendant's witness asserts that no benefit is gained by the defendant for failing to control cyanide because the defendant expects the United States will change the requirement without the need of costly input from the defendant. Other compliance scenarios, ones that are more deferential to environmental law and regulation, form the basis for economic benefit estimates for whole effluent toxicity (WET), cadmium, total suspended solids (TSS) and monitoring and reporting.

A second reason for the difference in estimates of economic benefit is the valuation method. In section 3, I show that Defendant's method of valuation by excluding a return to risk:

- misconstrues the meaning of economic benefit;
- fails to implement EPA's policy on economic benefit;
- undermines the deterrent effect of penalties;
- results in an estimate that creates an incentive to pollute; and,
- is unfair to those who do comply with pollution control regulations.

In Section 4, I comment on aspects of the report of Mr. Gene Andrews, another witness for Tech Cominco. Specifically, I address Mr. Andrews's use of the term feasibility and his belief that 'Feasibility is determined by evaluation of economic and environmental benefits and project costs.'⁴

I reserve the right to modify and supplement my opinions as further information becomes available, including through deposition of defendant's experts, and to express new opinions in response to new information or to opinions expressed by defendant's experts. Additionally, I have not been given access to several of the reports and publications on which Mr. Fuhrman and Mr. Andrews relied in making their opinion. Plaintiffs' counsel informs me that these documents were requested of Teck Cominco but have not been provided to plaintiffs. I reserve the right to modify and supplement my opinions once I have been provided all data and publications on which defendant's witnesses relied.

³ Typically a benefit arises because of a failure to install and operate pollution control equipment.

⁴ Expert Report of Gene Andrews, p.7.

The fact that I have focused on certain statements in the reports of Mr. Fuhrman and Mr. Andrews does not reflect my acceptance or agreement with any of their statements that I did not address. Finally, in reviewing the Andrews report, a number of lines of text were printed on top of each other, making it sometimes impossible to read the lines. This includes, but is not limited to, lines on page 2 (paragraph 2), page 3 (paragraphs 3 and 4), page 4 (paragraph 13, 15, 16), page 9 (paragraphs V and VI), and page 12. I reserve the right to modify and supplement my opinions once these lines are provided to me in a legible form.

2. Compliance scenarios

In this section I make some observations on the differences between the compliance scenario that underlies my analysis with the one underlying the defendant's analysis.

Claim 1. In my analysis I assume -- on the advice of plaintiffs' engineering experts -- that the defendant's wastewater exceedences at its mine site result from inadequate capacity to treat the runoff from its waste pile(s) as well as wastewater generated from concentrate production. Wastewater production from these sources are a foreseeable consequence of profitable mine operations. The defendant planned the expansion of production.⁵ The defendant knew what the permit limits

⁵ The 1999 Annual Report of Cominco Ltd., declares:

- "With the Red Dog expansion completed, the mine's concentrator has achieved operating rates that are consistently above its design capacity." p. 13;
- "Economies of scale have been realized from the Production Rate Increase Project completed in September 1998," p. 14; and
- "Long-term sales contracts were concluded for Red Dog's Production Rate Increase, resulting in Cominco now supplying 25 different customers on four continents." p. 26.

The 1999 Annual Report of Teck tells shareholders that: "A 50% production rate expansion program was completed (at Red Dog) in 1998. As a result production was at a record 930,000 tons of zinc concentrate. Early in 2000 Cominco announced a program to lift capacity to 1 million tons."

In its 1996 Annual report at p.30, Teck told its shareholders that Cominco "Following the discovery of an adjacent orebody and a 70% increase in reserves at Red Dog, a decision was reached in 1996 to expand its output by 40%. The increased capacity will result in the annual production of 800,000 tons of zinc concentrate and 160,000 tons of lead concentrate, or the equivalent of one billion

were. What the defendant failed to do was expand its mine site wastewater treatment plant to accommodate its increased production capacity. This failure to expand wastewater treatment capacity is a source of economic benefit. I assumed -- on the advice of plaintiffs' engineering experts -- that a process of planning and effecting pollution control was needed. The specifics of the process the defendants avoided are: \$1 million for a feasibility study; \$5 million for an investigation; at least \$15 million for capital improvements and \$750,000 per year for operations and maintenance.

Defendant argues that the permit modifications obtained in August 2003 could have been sought in 1993 so that the permit modifications would have become effective in September 1998. If the permit modifications were effective in 1998, the argument goes, there would have been no TDS violations. Defendant estimates it spent \$217,000 to get the permit changed.⁶ Defendant's argument is that its benefit arises because it didn't spend the money (e.g., purchase legal services) soon enough.

This argument suggests an incautious regard for human health and the environment. It suggests that an appropriate response of a company expanding production capacity, increasing its earnings, and using the waters of the United States to deposit its waste is to seek a reduction in the level of protection afforded to human health and the environment.

Claims 2 through 10. My estimate of economic benefit is focussed on the exceedences listed in the Revised Complaint's first claim. In my report I made no estimate of benefit arising from any other claim in the Revised Complaint. For claims 2 through 10 defendants offer a variety of compliance scenarios. For a critique of these scenarios I defer to plaintiffs' attorneys and engineering experts.

3. Economic benefit

I use the established method to estimate economic benefit. The defendant does not. The key difference between the methods is the basis for the

pounds of contained zinc and 185 million pounds of contained lead. The project is scheduled for completion in late 1998 at a cost of US\$104 million."

⁶ Fuhrman, Table 1, p.18; Table 1.A provides additional detail on the spending. I have not been able to review these charges. It appears that in excess of \$60,000 is for legal fees.

present value factor. I construct the present value factor in one of two ways, either:

- An equity approach which uses the capital asset pricing model calibrated for a project of average risk and combines a risk free rate plus a risk premium resulting in a factor of 13.4%; or,
- A weighted-average cost of capital approach which adjusts the equity result for the after-tax cost of debt. The adjustment reflects the company's proportions of debt and equity. It results in a factor of 11.1%.

Defendant's witness constructs a present value factor based only on a tax-adjusted, risk free rate. The rates varies monthly but when annualized ranges from less than 1% to just over 2.5%.⁷

The present value factor implements the common sense economic principle that a dollar today is worth more than a dollar tomorrow. It is a scale that states by how much a present dollar is expected to exceed a future dollar. This depends on the company's earning opportunities from its business resources. I estimate the earning opportunities for Teck Cominco in the range of 11.1% to 13.4%. Defendant estimates the range from less than 1% to just over 2.5%

USEPA's policy, USEPA's guidance on economic benefit, judicial opinion and the principles of economics and finance inform the following opinions about defendant's method of valuation. Because it omits an expected return to risk it:

- misconstrues the meaning of economic benefit;
- fails to implement EPA's policy on economic benefit;
- undermines the deterrent effect of penalties;
- results in an estimate that creates an incentive to pollute; and,
- is unfair to those who do comply with pollution control regulations.

⁷ Fuhrman, Table 1.E, Column headed "Interest forward Factor to PPD" annualized using the formula: $r = v^{1/t} - 1$ where r is annual rate, v is the interest forward value in the table, t is the time in years to PPD, the penalty payment date.

3.1 The meaning of economic benefit

From the outset to the present enforcement of the Clean Water Act is based on the concept that firms should not be allowed to gain from non-compliance.⁸ The following guidance on the subject dates from 1980.

“Delaying the purchase and operation of pollution control equipment results in economic savings or gains to the owner or operator of a facility. These savings or gains arise from two distinct sources: The opportunity to invest capital funds not spent to purchase and install pollution control equipment during the period of noncompliance, and the avoidance of the operation and maintenance expenses associated with the pollution control equipment during the period of delayed compliance (labor, materials, energy). These costs avoided represent permanent savings to the owner or operator; they may, of course, also be invested in income-producing ways. The economic benefits attributable to delaying capital expenditures and avoiding operation and maintenance expenses have been combined in a single formula. Because these benefits occur over a period of time, both past and future in some cases, the formula reduces these benefits to a present dollar value.”⁹

In the mid-1990s the trial judge wrote in *Friends of the Earth et al. v. Laidlaw*¹⁰

⁸ Economic benefit is not compensation to the public for the use of its water nor is economic benefit a damage calculation as in a typical tort case. Economic benefit is the amount to extract from the defendant to leave it in the same financial position it would have been in had it complied on time. BEN Users Manual, USEPA, September 1999, p.1-2.

⁹ ‘EPA Penalty Policy’, 1980, p.11.

¹⁰ 890 F. Supp. 470, 481-82 (D.S.C. 1995). The Laidlaw case had a complicated procedural history; after plaintiffs prevailed below, 956 F. Supp. 588 (D.S.C. 1997), the case was vacated by the Fourth Circuit on standing grounds, 149 F.3d 303 (4th Cir. 1998) and ultimately reinstated and remanded by the U.S. Supreme Court, 528 U.S. 167 (2000).

The defendant, as a holder of an NPDES permit, should not profit from non-compliance with that permit. If DHEC (Department of Health and Environmental Compliance) assessed a penalty that was below the Defendant's economic benefit of non-compliance, DHEC would not have penalized the Defendant at all; instead, the Defendant would have been rewarded for noncompliance with its permit.

Economic benefit is the after-tax present value of avoided and delayed expenditures on necessary pollution control measures. Economic benefit represents the opportunity a polluter had to earn a return on funds that should have been spent to purchase operate and maintain appropriate pollution control devices....

Present-value analysis of economic benefit allows one to express all cash flows as of given date by accounting for the fact that a dollar today is worth more than a dollar tomorrow. To determine by how much the value of a dollar of one year exceeds the value of a dollar of another year, one must use a discount rate to calculate the present value of money from the various time periods. The discount rate, or opportunity cost, represents the return the Defendant had the opportunity to obtain by investing the funds it delayed or avoided spending on pollution control measures. This rate can be used to move dollars through time and determine the Defendant's economic benefit as of a given date.

The court adopts the capital asset pricing model as the appropriate method for determining the benefit of non-compliance. Under the capital asset pricing model, the discount rate is computed using a risk-free component which is based on short-term United States Treasury Bills, and a near-constant risk premium. Using the capital asset pricing model, Dr. Michael Kavanaugh, the Plaintiffs' economic expert determined that the appropriate discount rate for this case is 15.25%. [Footnote omitted]

The latest USEPA guidance on economic benefit states:

'Economic benefit represents the financial gains that a violator accrues by delaying or avoiding pollution control expenditures.

Funds not spent on environmental compliance are available for other profit-making activities, or, alternatively a defendant avoids the costs associated with obtaining additional funds for environmental compliance. (This concept is known in economics as opportunity cost.) Economic benefit calculates the amount by which a defendant is financially better off from not having complied with environmental requirements in a timely manner. Economic benefit is 'no fault' in nature. A defendant need not have deliberately chosen to delay compliance (for financial or any other reason), or in fact even been aware of its noncompliance, for it to have accrued the economic benefit of non-compliance.

The appropriate economic benefit calculation should represent the amount of money that would make the violator indifferent between compliance and non-compliance".¹¹

An economic benefit analysis must make an informed estimate of the amount expected to be earned on the avoided funds. This is done by using established economic constructs such as the capital asset pricing model or weighted-average cost of capital and if available by the defendant's own expectations of earnings.

For example, Cominco's 1999 Annual report states a financial goal as "... earn[ing] our cost of capital even at the bottom of the metal cycle." (p.8). In reference to Red Dog, the Annual Report in its highlights section declares that 'Red dog achieved a rate of return on capital employed of 15% even though metal prices were relatively low throughout much of the year. This rate of return exceeded the company's estimated cost of capital of 10%.' (p.5)

For profit firms--like the defendants-- are designed to bear risk. To be consistent with removing the gain from avoiding pollution control spending; to make the violator indifferent between compliance and non-compliance; and, to be consistent with twenty-five years of policy,

¹¹ Ben User's manual, USEPA, September 1999, p.1-2.

guidance and opinion, an economic benefit estimate must reflect the earnings from risk bearing.¹²

Management must bear risk. If a company's management does not bear risk another management group will come along and take over the firm. I think bearing an average level of risk is sufficient to deter take-over. Accordingly, a firm will invest in projects that exhibit risk and should have its economic benefit calculated using opportunity costs that reflect average risk. Defendant's estimate excludes an expected return to risk. Accordingly, it does not measure economic benefit and is contrary to EPA policy and guidance.

3.2 Incentives and Deterrence

Removing economic benefit helps to ensure that members of the regulated community have a strong economic incentive to comply with environmental law.¹³ Suppose a firm avoids pollution control, invests the avoided funds, is caught, and is penalized. If the penalty is based only on the risk-free return as defendant's witness would have it, and the firm invested in risky projects -- the normal and expected behavior of a for-profit firm-- the economic benefit has not been removed. The firm earned a risk-free rate plus a risk premium rate but was only penalized at the risk-free rate. The firm retains the risk premium and an incentive to pollute is created.

Moreover, failure to remove economic benefit undermines the goal of deterring future noncompliance. Other companies are subject to Clean Water Act regulations.¹⁴ When they see that one of their competitors has avoided pollution control and has been permitted to keep the risk premium from investing the funds that should have been spent on pollution control, then these other companies will see an economic advantage in similar noncompliance.

¹² It has been long acknowledged that if a violator can achieve compliance by reducing production volume then it is incumbent that it do so. Reduction in production volume reduces the firm's total return not just the risk-free return.

¹³ Ben User's Manual, USEPA, September 1999, p 1-1.

¹⁴ The USGS Minerals Yearbook --2002 discloses 11 active zinc mines in 5 states (See Zinc section p.1). Table 3 of the yearbook shows the 9 largest U.S. mines.

3.3 Equity

Those firms who do comply with environmental law and regulation are treated unfairly if the economic benefit from noncompliance is not removed from firms that violate the law. Firms (e.g., zinc mines) who comply with the Clean Water Act and its implementing regulations must use scarce resources to manage and treat contaminated waters that are produced as a consequence of their actions. These funds could be used in other projects that on average have a return that reflects risk bearing. Allowing a competitor to delay compliance and keep part of the earnings on the funds that should have been spent for compliance provides the non-complying firm with a financial advantage over its competitors. This is unfair to the law-abiding competitors.¹⁵

4.0 Feasibility

Mr. Andrews, one of defendant's witnesses, defines feasibility as an evaluation of economic and environmental benefits and project costs. This is a troubling statement for two reasons. First, Congress delegated authority for setting discharge limits to the Environmental Protection

¹⁵ The U.S. Congress has endorsed this sentiment on at least two occasions. During the 95th Congress in Senate Report 370, 70. "The conferees deleted a provision in the Senate-passed bill which required the Administrator to assess a noncompliance fee. The fee was seen as unnecessary because **(EPA) policy embodies congressional intent on the criteria that should be considered by courts in imposing civil penalties under existing provisions of the act** (emphasis added)." (Note: EPA policy calls for removing all of the gain not just the risk-free gain from non-compliance)(note added). During the 99th Congress in 1985 Mr. DOLE (for Mr. CHAFEE) submitted the following: "The amendment would also expressly require the courts to consider a number of factors, including, in particular, the economic benefit gained as a result of the violation. Violators should not be able to obtain an economic advantage vis-a-vis their competitors due to their noncompliance with environmental laws. The determination of economic benefit or other factors will not require an elaborate or burdensome evidentiary showing. Reasonable approximations of economic benefit will suffice. Other objective factors customarily taken into account in assessing penalties, such as the history of violations, good faith efforts to comply and economic impact on the violator, also may be taken into account in arriving at an appropriate penalty." Committee on Environmental and Public Works 99th Congress Senate Report 50, 25

Agency not the permit holders, and Congress has declined the opportunity to require a cost benefit test in setting discharge limits. Second, feasibility means capable of being done. The defendant proceeded with the Production Rate Increase Project and expanded production. If the project was feasible only if discharges were not controlled and the permits limits were consistently exceeded then the defendant expanded production prematurely and obtained sales revenues sooner than it should have. In other words it gained an economic benefit from early production. This benefit may be materially greater than the benefit from avoiding a process of planning and effecting pollution control.

4.1 Technology based standards

The Clean Water Act relies on technology based controls to protect human health and the environment. The statute directs the Environmental Protection Agency to control discharges to the water of the United States using the best available technology taking into account the cost of achieving effluent reduction (i.e. cleaner water). This directive to consider the cost of achieving cleaner water is an instruction to perform cost-effectiveness analysis. That is, it is a directive to answer the question "How much does it cost to remove contamination?" It is not a directive to answer questions about environmental benefits such as: "Is removing the contamination worth it to human health and the environment?"

Since its passage in 1972, The Clean Water Act has been repeatedly subject to reauthorization. During reauthorization Congress has declined repeatedly to require a cost benefit analysis when setting standards to control water pollution. I believe the reason for this is simple. The benefits of protecting human health and the environment, though real, are very difficult to value in dollar terms. Simply suggesting that there might be a dollar value (or even a range of dollar values) to a human life is a good way to enter into a very emotional argument. Estimating the cost of a pollution control is much easier by comparison. Given the mismatch in our analytical abilities to determine relative cost and benefits in dollar terms, Congress has simply refused to order that it be done.

4.2 Feasibility

A project (like the defendant's Production Rate Increase Project) is economically feasible if it is capable of being done. In a market economy a project is capable of being done if over the life of the project it can return an excess of revenues over costs. In other words, a project is feasible if consumers are willing to pay what it costs to produce the product. Economic feasibility, then, is a broadly focussed measure of the performance of the entire project (not just the pollution control part or just the marketing part, or the mining part) from the point of view of the firm.¹⁶

A feasible project may have several parts. One or more of the parts may be expensive. By itself this not enough to make the project economically infeasible. The project remains feasible if it produces a positive net present value. Ultimately in a market economy it is the consumer who determines economic feasibility.

A demonstration of economic feasibility needs a calculation that includes not only the costs of production including the costs of controlling discharges, but also consumers' willingness to pay. Consumers of products (in this instance zinc concentrate) whose production contaminates the water may be willing to pay the full costs of production including the costs of water pollution controls. Mr. Andrews's analysis of feasibility on p.10 of his report does not consider the willingness of consumers to pay for controls and in so doing omits key evidence. On the face of it, the feasibility of the Production Rate Increase project with and without pollution controls cannot be determined from Mr. Andrews's analysis.

In the alternative,

- since the defendant had to comply with the terms of its permit to use the waters of the United States; and,

¹⁶ More formally, economic feasibility considers all of the project's revenues over time, discounted to present value, and adjusted for taxes compared to all of the project's costs over time also discounted to present value and adjusted for taxes. If the after-tax present value of the revenues exceed the after-tax present value of the costs then the project is feasible

- if the defendant's Product Rate Increase project was feasible only if discharges were not controlled to the limits of its discharge permit as Mr. Andrews seems to suggest;
- then the defendant expanded production prematurely; and in so doing,
- gained the use of revenues sooner than it would have had it waited until it could control discharges to the limits of its permit.

In other words it gained an economic benefit by having the use of the revenues from early production.¹⁷

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 Annual Reports of Teck Cominco Alaska Incorporated 1999 to 2003.

¹⁷ If Teck Cominco had to curtail operations completely to comply with its permit from June 1999 to August 2003, I estimate it gained a \$69 million benefit from early receipt of the operating cash flow from its Red Dog operations. Complete curtailment of its operations at Red Dog, however, may not have been needed for compliance. In that event, the \$69 million estimate is an overestimate of the benefit from early production. If, for example, a 50% reduction in output would achieve compliance then the benefit is about \$34.5 million. These estimates are based on operating cash flows reported in Teck Cominco Alaska Incorporated's financial reports 1999 to 2003, Teck Cominco's weighted-average cost of capital, and linearity in production and cost.